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NASA TECH BRIEF

Development of Reliability Prediction Technique for Semiconductor Diodes

A project was initiated to develop a new and more fundamental approach to reliability prediction for semiconductor diodes based on realistic mathematical models. The hope was to achieve a breakthrough from the theoretical side using a knowledge of the basic physics and mathematics to provide a bridge of rationale and technique for scientific guidance of reliability prediction.

The art of failure prediction has been based largely on empirical data and routine application of the Inverse Product Rule. Although much has been learned in recent years about the Physics of Failure in component parts, there has been little or no theoretical means for making use of this information in failure rate prediction. There has been no "law" of failure for prediction purposes. It is believed that this desired "law" has now been developed.

To limit the scope of the project to a practical range, the field effort was centered on semiconductor diodes in general, on silicon diodes primarily, and on five typical types for detailed analysis. These five basic types are:

(1) General purpose
(2) Computer and switching
(3) Zener or reference
(4) Power or rectifier
(5) Varactor (variable reactance)

The following parameters were included:

(1) Mechanical degradation (gross physical-macrostructure)
(2) Electrical degradation (chemical-microstructure)
(3) Environmental stress factors
    Shock
    Constant acceleration
    Temperature (operating, junction)
    Radiation (particulate, nonparticulate)
(4) Electrical load stress factors
    Current
    Power
    Voltage
(5) Quality adjustment factor

Notes:

1. Some of the uses of the failure prediction "law" may be summarized as follows:
   (a) To determine whether a lot of parts is typical of the standard part.
   (b) To establish a new model for similar but different types
   (c) To evaluate the differences between supposedly identical lots
   (d) To compare products from different suppliers
   (e) To evaluate consistency of quality control in a supplier's plant from lot to lot
   (f) To compare the effectiveness of quality control between suppliers for the same type parts
   (g) To establish new constants and models for different part types
   (h) To purify and perfect the model to deeper levels of interaction simulation
2. Although the project emphasized specific application to certain types of silicon diodes, the technical approach developed should be useful with all other types of components including integrated microcircuits.

(continued overleaf)

3. Complete details of this development are contained in: *Project "Diode Reliability Prediction Technique"*, by C. M. Ryerson, NASA CR-702, Hughes Aircraft Company, February 1967. Copies of this report are for sale by the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price $2.50.
4. Inquiries concerning this development may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland 20771
   Reference: B67-10651

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: C. M. Ryerson
of Hughes Aircraft Company
under contract to
Goddard Space Flight Center
(GSC-10231)